LOYOLA OF MONTREAL

MATHEMATICS

STUDENT'S HANDBOOK
FOR
1968 - 1969

DEPARTMENT OF MATHEMATICS

	NAME	RANK	FIELD OF INTEREST
1.	A. J. Prillo	Assoc. Prof. and Chairman	Analysis
2.	Rev. Dr. E. O'Connor S.J.	Prof.	Analysis
3.	Dr. I. Benjamin	Assoc Prof.	Complex Analysis
4.	Dr. I. Shtern	Assoc Prof.	Complex Analysis
5.	Dr. M. Faierman	Asst. Prof.	Differential Equations
6.	Dr. K. N. Majumdar	Asst. Prof.	Combinatorics
7.	R. C. Moore	Asst. Prof.	Statistics
8.	J. B. Sabat	Asst. Prof.	Numerical Analysis
9.	J. Soric	Asst. Prof.	Topology and Differential Equations
10.	T. Srivastava	Asst. Prof.	Differential Geometry Integral Transforms
11.	G. Bashconji	Lecturer	Applied Mathematics
12.	H. Fainsilber	Lecturer	Algebra
13.	H. Greenspan	Lecturer	Algebra
14.	Dr. N. Govil	Lecturer	Fourier Series and Complex Analysis
15.	C. Hewson	Lecturer	Algebra Mathematical Education
16.	H. Kim	Lecturer	Algebra and Topology
17.	Rev. J. G. McDonough S.J.	Lecturer	Mathematical Education
18.	E. Storr	Lecturer	Analysis

The Department of Mathematics is located on the third floor of the Hackett Bldg., 7270 Sherbrooke St. W. The telephone local is 361.

THE TWENTY-NINTH ANNUAL

WILLIAM LOWELL PUTNAM MATHEMATICAL COMPETITION

One of the most respected mathematical competitions in North America is the William Lowell Putnam Mathematical competition. It is restricted to undergraduate students and the compeition is held annually in about the third week of November. The examination is administered at the college or university where student is enrolled consisting of two three-hour sessions (usually held on a Saturday) with six problems each.

HISTORY

The competition began in 1938 and is designed to stumulate a healthful rivalry in mathematical studies between colleges and universities of the United States and Canada. It exists because Mr. William Lowell Putnam had a profound conviction in the value of organized team competition in regular college studies. Mr. Putnam, a member of the Harvard class of 1882, wrote an article for the December 1921 issue of the "Harvard Graduate's Magazine" in which he described the merits of an intellectual intercollegiate competition. To establish such a competition Mrs. Putnam in 1927 created a trust fund known as the William Lowell Putnam Intercollegiate Memorial Fund. The first competition supported by this fund was in English and a few years later a second experimental competition was held, this time in mathematics between two institutions. It was not until after Mrs. Putnam's death in 1935 that the examination assumed its present form and was placed under the administration of The Mathematical Association of America.

ELIGIBILITY

The competition is open only to regularly enrolled undergraduates, in colleges and universities of the United States and Canada, who have not yet received a college degree. No individual may participate in the competition more than four times.

DESCRIPTION

The examinations will be constructed to test originality as well as technical competence. It is expected that the contestant will be familiar with the formal theories embodied in undergraduate mathematics through differential equations. It is assumed that such training, designed for mathematics and physical science majors, will include somewhat more sophisticated methematical concepts than is the case in minimal courses. Thus the differential equations course is proposed to include some references to qualitative existence theorems and subtleties beyond the routine solution devices. Questions will be included which cut across the bounds of various disciplines and self contained questions which do not fit into any of the usual categories may be included. It will be assumed that the contestant has acquired a familiarity with the body of mathematical lore commonly discussed in mathematics clubs

or in courses with such titles as "survey of the foundations of mathematics". It is also expected that the self contained questions involving elementary concepts from group theory, set theory, graph theory, lattice theory, number theory, and cardinal arithmetic will not be entirely foreign to the contestant's experience.

All contestants, including team members, work independently on the problems. There is no collaboration among members of the team.

PRIZES

The prizes to be awarded to the departments of mathematics of the institutions with the winning teams are $500, $400, $300, $200 and $100, in the order of their rank. In addition, there will be prizes of $50, $40, $30, $20 and $10 awarded to each of the members of these teams according to the rank of team, a prize of $75 to each of the five highest contestants, and a prize of $35 to each of the succeeding five highest contestants. Each of the winners will receive a suitable medal. In case winning contestants wish to purchase books with their prize money, suitable bookplates will be furnished them indicating that the book was purchased with money won in the William Lowell Putnam Mathematical Competition. Honorable mention will be given to several teams next in order after the five winning teams and to several individuals next in order after the ten individual winners.

ANNOUNCEMENTS

The names of the top 500 contestants will be forwarded to all participating institutions. They will be grouped into about five categories according to their rankings but specific scores or rankings will not be included.

The names of the institutions with the five winning teams (in order of their rank), the names of the members of these teams, the names of the five persons whose positions in the examination are highest (without indicating their relative positions) and of the five next highest in rank (likewise without indicating their relative positions) will be published in the American Mathematical Monthly. There also will be published in the Monthly the names of the members of the teams winning honorable mention (all without indicating their relative positions). In case of ties, the list may be increased as far as necessary.

SCHOLARSHIP

To further encourage the competition, the trustees of the Putnam Fund will award at Harvard University (or at Radcliffe College in the case of a woman) the annual William Lowell Putnam Prize Scholarship to one of the five highest contestants. This scholarship is available either immediately or on completion of the undergraduate course of the successful candidate and carries a value

of $2,500 plus tuition at Harvard.

Institutions throughout the United States and Canada are encouraged to offer scholarships to high ranking contestants of the competition.

Last year, in the 28th competition, Loyola was represented by twelve students. It was only our second entry and with a rather limited preparation, the team ranked 179th among 223 colleges and universities in the United States and Canada. All in all, 1592 students participated and the top three students from Loyola were Ronald Leeks (rank 630), Edward Muldoon (rank 777) and Gregory Glanshan (rank 836). Incidentally, Mr. Glanshan is currently the President of the Loyola Mathematical Society.

It is hoped that more of our students will show interest in this year's 29th annual competition. For those interested a complete set of previous examination papers (and solutions) has been prepared and may be obtained from Gregory Glashan (team captain for the 29th competition) or from Prof. J. B. Sabat (Math. Dept., Room 28B).

As an example of the types of problems encountered in this competition, following are a few sample problems from last year's examination:

Problem A-1

Let $f(x) = a_1 \sin x + a_2 \sin 2x + \ldots + a_n \sin nx$, where $a_1, a_2, \ldots, a_n$ are real numbers and where n is a positive integer. Given that $|f(x)| \leq |\sin x|$ for all real x, prove that $|a_1 + 2a_2 + \ldots + na_n| \leq 1$.

Problem A-3

Consider polynimial forms $ax^2 - bx + c$ with integer coefficients which have two distinct zeros in the open interval $0 < x < 1$. Exhibit with proof the least positive integer value of a for which such a polynomial exists.

Problem A-5

Show that in a convex region in the plane whose boundary contains at most a finite number of straight line segments and whose area is greater than $\frac{\pi}{4}$ there is at least one pair of points a unit distance apart.

Problem B-3

If f and g are continuous and periodic functions with period 1 on the real line, then $\lim_{n\to\infty} \int_0^1 f(x)\, g(nx)\, dx = \left(\int_0^1 f(x)dx\right)\left(\int_0^1 g(x)dx\right)$.

Problem B-5

Show that the sum of the first n terms in the binomial expansion of $(2 - 1)^{-n}$ is 1/2, where n is a positive integer.

Problem B-6

Let f be a real-valued function having partial derivatives and which is defined for $x^2 + y^2 \leq 1$ and is such that $|f(x,y)| \leq 1$. Show that there exists a point (x_0, y_0) in the interior of the unit circle such that $\left(\frac{\partial f}{\partial x}(x_0, y_0)\right)^2 + \left(\frac{\partial f}{\partial y}(x_0, y_0)\right)^2 \leq 16$.

LOYOLA MATHEMATICAL SOCIETY

The Loyola Mathematical Society, better known as the Math. Club, was formed during the academic year 1966-67. Membership was restricted to Loyola students interested in Mathematics. During the past two years the club's membership has risen from 8 founding members to about 60.

For the academic year 1968-69 the club has a very able executive (see below) and the activities planned indicate that it should prove to be a very interesting year. This academic year, every student honouring or majoring in mathematics will automatically become a member, while others interested - especially freshmen - are cordially invited to join.

L.M.S. Executive for 1968-69:

Gregory Glashan, President	489-2620
Algis R Vilciauskas	681-4559
Peter Maertens	684-7716
Maria Jakimowicz	484-7009
Wynford Godard	697-4591

SOME REMARKS ON CAREERS IN MATHEMATICS

In reply to many requests by students as to the possible careers in Mathematics upon graduation, the Department of Mathematics has prepared the following information pamphlet. While the careers discussed below are primarily for mathematicians, a great many of the remarks apply to propsective graduates in science or engineering (any good modern engineering course involves a great deal of mathematics.)

We hope these general remarks will open to the student a number of avenues in mathematics and at the same time give some idea as to what mathematicians do.

GOVERNMENT RESEARCH

Government Departments, such as the National Research Council and the Defence Research Board, employ many mathematicians and scientists. The minimum requirement is an Honours B.A. and it is desirable to have an M.A. or a Ph.D. The Bachelor's Degree barely qualifies one to do research past the technician level, and it is natural that the most stimulating and most interesting research positions go to those persons who have had graduate training. Normally, a Master's degree will take one to two years work past a Bachelor's degree, and a Doctoral degree will take two or three years past the Master's degree.

INDUSTRIAL RESEARCH

Many industrial corporations run research laboratories; for example, The Bell Telephone, The Aluminum Company of Canada, General Electric, and many other corporations. The same remarks made concerning governmental research apply to industrial research; a Ph.D. degree is highly desirable and almost essential, although jobs at a lower level are available to persons with Bachelor's degrees and especially those with Master's degrees. Among the branches of Mathematics most important at the present time as regards their applications in either Governmental Research or Industrial Research, particular mention should be made of Statistics (especially such topics as Experimental Design and Quality Control), Applied Probability, Information Theory, Operations Research, and Computer Science.

Although a detailed description of the numerous branches of mathematics in industry is beyond the scope of this pamphlet, we hope the following remarks will give some idea of what is currently being done in several branches:

PURE AND APPLIED STATISTICS

In the modern sense, statistics and statisticians are concerned with the development and application of methods and techniques for collecting, analysing, and interpreting quantitative data in such a way that the reliability of conclusions based on the data may be evaluated objectively in terms of probability statements.

In the last two decades a new concept, statistical decision theory was developed. This concept is broad enough so that everything that is currently part of the subject matter of statistics may be considered a special case of statistical decision theory. From the decision theory point-of-view, statistics is a body of knowledge that is used for making the best possible decisions in the face of uncertainty.

Statistics should not be thought of as being committant to any one science. It provides a kit of tools that are valuable aids to research in engineering as in biological sciences and in the physical sciences as well as in the social sciences. The problems may be very different, but the scientific method is common to all. Roughly speaking, statistical activities can be classified as belonging to one of two major areas: theoretical or mathematical statistics and applied statistics. Theoretical statistics is concerned with the mathematical elements of the subject; we look to the mathematical statistician for the development of new theories that will provide new tools with which to attack practical problems.

To the applied statistician, statistics is a means to an end: he uses statistics to solve problems in many areas. For example, he may be asked to assist in designing a sample survey; he may be consulted with regards to sampling inspection schemes for statistical quality control, or asked to participate in the designing of an experiment. Frequently he is presented with a set of data and requested to provide an analysis and interpretation, often a frustrating task beacuse the method of analysis is dependent upon the way in which the data was collected. In the main, applied statisticians are consultants to administrators and research workers in industry, in Government and in academic institutions.

Other area of application are suggested by other subdivisions of statistical methods: statistical quality control, genetic statistics, business statistics, psychological statistics and so on.

COMBINATORICS

Combinatorics, also referred to as combinatorial mathematics and combinatorial analysis, can be described as the study of the arrangement of elements into sets. Examples of this type of mathematics are found in magic squares known to the Chinese 4000 years ago, in permutations studied at least 3000 years ago, and in today's newspapers which occasionally publish mathematical puzzles of a combinatorial nature. The earlier ideas were quite naturally related to number mysticism but in time the subject came to be considered as mathematical recreation. It is interesting to observe that many of those problems studied in the past for their amusement or aesthetic appeal are of great value today in pure and applied science. For example, finite geometries which were regarder a few decades ago as a combinatorial curiosity, today play a basic role in the foundations of geometry and in analysis of design of experiments.

Fascinating new combinatorial problems have arisen in the study

of both pure and applied mathematics. A particularly fine example is the Theory of Linear Graphs which has recently blossomed.

Combinatorics cuts across many areas of mathematics and researchers in the field today study a wide diversity of intriguing problems. There is an increasing demand for combinatorial specialists in industry as well as in universities. Students interested in more information on this subject are referred to an excellent text in our library: Introduction to Combinatorial Analysis by Riordan (512.5,R 5850).

OPTIMIZATION

A variety of mathematical methods have recently evolved which can be classified as optimization techniques. Every student of calculus finds the maximum or minimum of a function by setting its derivative equal to zero. The engineer uses more sophisticated methods of analysis to optimize hardware design.

Optimization is particularly important in business and industry. For example, in an inventory or a scheduling problem the purpose of developing a mathematical model is to minimize cost or maximize efficiency or some other criterion.

During the past decade several new general optimization techniques (e.g. linear programming, dynamic programming) have been developed specifically to handle such optimization problems. A possible career in "applied optimization" is in the field of operations research.

OPERATIONS RESEARCH

As a member of an Operations Research Group, the mathematician works closely with scientists in other fields on problems directly related to management decisions. Since an operations research team is always interdisciplinary and may include physicists, chemists, biologists, economists, psychologists and management specialists as well as mathematicians and statisticians, this career will appeal to students who enjoy working with others and have wide interests. A Bachelor's Degree is sufficient to obtain such employment. However, a Master's Degree and a Ph.D. Degree will usually enable an Operations Research Specialist to rise rapidly in management ranks.

ACTUARIAL WORK

An actuary is a professionally trained business executive who specialized in the science of mathematical probabilities, refined to space-age efficiency. He plays a principal role in the planning and operation of life insurance and pension programs.

The development of these programs presents the actuary with many stimulating challenges. He utilizes his mathematical training

and talents to design insurance services which adequately meet the public's needs and desires, and which remain financially sound. The actuary, in many respects, is the "engineer"of the insurance business providing essential problem analysis in the development of many executive decisions. His job is varied. He may be responsible for: transferring data-processing operations to an electronic computer system, problem solving by operations research techniques, determining the cost of an increase in pension benefits for college professors or studying the effect on company profits of a possible decline in interest rates on new investments. However, his prime responsibility is the sound financial welfare of his company.

Fellowship in the Canadian Institute of Actuaries is attained by passing ten examinations set by the Society of Actuaries. While not a formal requirement, a university education provides a solid foundation on which to build an actuarial career, particularly when mathematical subjects are studied. Courses in actuarial science are offered at the Universities of British Columbia, Manitoba, Toronto, Waterloo and Western Ontario and at Laval and Queen's Universities. It is to the student's advantage to try the first two examinations while attending university. They are set on basic mathematical subjects - algebra, geometry, trigonometry, calculus, probability and statistics. A student who passes the first few exams while at university must count on four or five years of study following graduation to complete all ten examinations. The later examinations test the student on the more advanced mathematical and business aspects of a wide range of insurance and pension programs. The student intent on an actuarial career can promote his ambition greatly by seeking summer employment in a life insurance office while at university.

The prospective actuary can pick and choose jobs. There are many openings for actuaries in the insurance companies in Canada alone. In addition, many opportunities have been created in actuarial consulting firms, industry and government, due to the increasing number of pension plans being introduced. Actuaries in the consulting field offer a wide and varied range of services. Their clients include smaller insurance companies with no actuaries of their own, trust companies and labour unions that administer pension plans, and business firms and government agencies that require administrators and technical advisers in the operation of employee benefit plans.

The substantial starting salary for actuarial students compares favourably with other occupations requiring comparable abilities and training. Moreover, the actuarial profession has a tremendous advantage- good earnings while the student is attaining a professional status. Salaries increase rapidly with experience and the assumption of wider responsibilities. It is not uncommon to find an actuary as Vice-President, President or Board Chairman of his company. For additional details concerning enrolment, examinations, aptitude tests and employment opportunities, write to: The Secretary, Canadian Institute of Actuaries, 10th Floor, 302 Bay Street, Toronto, Ontario.

THE ELECTRONIC COMPUTER INDUSTRY

One of the major developments of the past fifteen years has been the growth of the electronic computer industry; there are a great variety of interesting positions available in this industry involving training all the way from the Bachelor's level to the Ph.D. level. Indeed, many stimulating tasks can be performed by people whose background training is only at the Bachelor's level, although naturally the more training one has the better one can proceed. Openings in the electronic computer industry are basically of two kinds. Companies such as International Business Machines (IBM) which actually produce electronic computers need a great many men who know Mathematics and can develop programmes for the use of computers; these men are also needed to develop programmes for customers and explain the uses of the machines to these customers. On the other hand, companies which buy electronic computers immediately need to employ mathematicians and scientists to run these computer, to do research on problems which will be placed on the computers, and to develop methods whereby difficult problems can be solved on electronic computers. Some of the organizations which make extensive use of electronic computers are Insurance Companies, Aircraft Corporations, Petroleum Companies, Government Agencies and Departments, Universities, etc.

Practically every university now owns an electronic computer, uses it is instruction in undergraduate courses, and uses it as a tool for research and problem solving.

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CAREERS FOR WOMEN

It is not generally realized that, in many foreign countries, far more women enter careers in mathematics (and also in Science and Engineering) than in Canada. Girls who wish to enter mathematics should not feel that they are restricted to a teaching career; the same opportunities are open to them as to men in business, government, and industry. Indeed, the electronic computer field is especially suitable for a woman mathematician, since she often possesses above-average qualities of carefulness, organization, memory and ingenuity. Another field where enormous opportunities for women abound is in the joint study of Mathematics and Psychology; modern work in Psychology, both in pure research and in application, leans heavily upon Statistical Analysis, Experimental Design, and other branches of Mathematics.

HIGH SCHOOL TEACHING

At the present time, there is still a great shortage of High School teachers who are adequately trained in mathematics or in science. A student who graduates from university with a general degree, majoring in mathematics may teach mathematics in the high schools after having completed one additional year at a teachers

college. However, he would be well advised to obtain an Honours degree in Mathematics rather than a General with Mathematics as a major. A student with an Honours degree can expect, with the present shortage of qualified mathematics teachers, to become head of a Mathematics Department in a secondary school within a relatively short time. Students who possess the ability to organize and present their ideas clearly, who like working with young people, and who are fond of mathematics, can find high school teaching a very rewarding profession. A student who enters this profession should make a resolution to keep up-to-date in his mathematics by periodically taking refresher courses, reading new texts, or taking summer courses.

UNIVERSITY TEACHING

With few exceptions, a University professor requires the M.A. or Ph.D. degree. This will mean that he has spent some years past on an Honours Bachelor's Degree, has done research of his own to qualify for the degree, and is presumable carrying on further research while serving as a University professor. The ideal professor is a good research worker, a keen scholar in his own subject, and an interesting and inspiring teacher to his students; Naturally, not every professor can achieve this ideal, but we all try to do our best. If a student is gifted in mathematics, likes explaining mathematics to others, likes mathematics for its own sake, and has genuine affection and feeling for other people, then he should make a good university professor. A professor must be interested in his work and interested in his students. The work is hard and time-consuming, but it is very rewarding to those who feel the urge to enter the profession.

At the present time, shortage of University professors is becoming increasingly acute. Reliable estimates of student enrolment in the next few years show that there will be a need for over ten thousand new professors in Canada by 1970! In an attempt to alleviate this shortage, there are various graduate fellowships available to students in Arts and Science who elect a career of University Teaching. These fellowships range from $1500 to $3500 per annum, depending upon merit. Consequently, any student with ability who wants to carry on graduate work and equip himself for a career in University teaching will be able to do so, and even to do so under good financial arrangements.

One should also mention that university salaries are on the rise - as in many other professions - and that the acute shortage of professors seems destined to last for a long time.

CONCLUSION

No student entering the field of mathematics need feel that he will have any difficulty in obtaining a position. At the moment, mathematicians are probably scarcer than ony other type of animal. This is probably because of the fact that the electronic

computer industry has been attracting more and more mathematicians away from the older and more traditional lines of activity.

Also, the student entering a mathematics course need not have, at the beginning, a clear-cut idea of what he wishes to do when he graduates. During the course, he will be closely associated with other students and will come to know very well a number of his professors. The associations and friendships which he develops in his college career with his fellow students and his professors will help him in choosing a profession when he graduates; the more he learns about mathematics as he goes through his course, the easier it will become for him to decide just what he wants to do with his mathematical knowledge. The essential thing is for a student to make the most of his college course; he must make the most of it culturally by taking part in extra-curricular activities, taking courses and doing reading in fields which are not his major field of study, and rounding out his over-all knowledge by discussions with other people in the college; finally, he must make the most of it personally by developing the acquaintances and friendships which will be with him the rest of his life.

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MATHEMATICAL PERIODICALS AT LOYOLA SCIENCE LIBRARY

The Science Library currently subscribes to 73 different mathematical journals and periodicals. Whereas most of these contain research papers of high calibre that are rather difficult for the majority of students to follow, there are a few which are primarily student oriented:

1. The American Mathematical Monthly.
2. Fibanacci Quarterly.
3. Mathematical Gazette.
4. Mathematics Magazine.
5. The Mathematics Student.

THE MASTER OF PHILOSOPHY DEGREE

H. C. Eastman*

Several universities in Canada, the United Kingdom and the United States have established a new graduate degree, the Master of Philosophy. Concern for the best use of human resources by universities and, more yet, for the welfare of those who have received the Phil.M. prompt this explanation of the need for the new degree and of its nature and brief history at the University of Toronto. It is only when the characteristics of the Phil.M. are widely known that the danger of a possible undervaluation of the qualifications for university teaching of those who hold the degree will be avoided.

The Master of Philosophy was established in response to two clear needs. The first is to provide well-trained staff for faculties of Canadian universities which are inexorably greatly increasing in size; the second is to provide a graduate program more suited than the Ph.D. to certain types of intellectual interests and to certain individual wants.

The increasing number of men and women of university age and the increasing proportion of this group that wishes to go to university is causing the now well-understood expansion in enrollment in Canadian universities. This expansion is not only occurring at the undergraduate level but also in increasing proportion at the graduate level which absorbs greatly more faculty time per student than does undergraduate instruction. Both these needs point to the necessity of an increase in university faculty more than proportionate to the increase in student enrollment.

The increase in demand for university services that is occurring in Canada is also occurring elsewhere. This means that Canada who has traditionally relied heavily on graduate schools abroad, is now faced with the necessity of playing a much more important role than in the past in increasing the number of university teachers by training them in Canadian graduate schools. Should Canada fail in producing sufficient university teachers, the high standard of undergraduate instruction will decline, driving the best teachers to seek more favourable conditions for teaching and research abroad, and forcing the acceptance of inadequately trained faculty. The choice facing Canadian graduate schools then becomes one of speeding up the production of Ph.D.s, relying on the M.A. as sufficient training for university teaching, and introducing a new graduate degree.

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* Doctor Eastman is Professor in the Department of Political Economy, Associate Dean in the School of Graduate Studies (Division I: Humanities & Social Sciences) and Chairman of the Phil.M. Committee, University of Toronto.

This article is adapted from the Publication of The Canadian Association of University Teachers: Vol. 15, no. 1. October 1966.

The degree of Doctor of Philosophy is today the most important single indication that its holder has completed a course of study fully qualifying him for a university teaching post. However, the production of Ph.D.s cannot be increased rapidly owing to the period of four to eight years from first enrollment as a doctoral candidate usually necessary to complete all the requirements for the degree including the thesis. Doctorates in the physical sciences are typically completed in the lower and in the social sciences and humanities in the upper part of this range of years. The Master of Arts or of Science degree is today not sufficient training for new faculty members in view of the increase in knowledge that is currently taking place. It is true that holders of only the M.A. do obtain teaching positions in the currently very strong market for university teachers. But they risk being seriously handicapped in their career by a background usually inadequate for the demands that teaching will put upon them in the future and in their competitive position with respect to other better trained colleagues. The University of Toronto saw in the inadequacy of the M.A. for university teaching and in the manifest demand for vastly increased staff one source of need for a qualification senior to the M.A. and capable of being obtained more quickly than the Ph.D.

But the only justification for the new degree, the Master of Philosophy, was not the simple need for more university teachers. The Phil.M. was established also in part because of the shortcomings of the Ph.D. as the single instrument of training university teachers. It is of course true that the Ph.D. is the best training that has yet developed for the research scholar, and it is acknowledged that the productive research scholar is essential to the well-being of the university. But the present practice of treating the Ph.D. as virtually the single requirement for a full academic career is harmful to many individuals and indeed to Ph.D. programs themselves. In literature, for instance, an individual who wishes to make his scholarly contribution in the field of criticism may be handicapped in his efforts by the need to fit his program within the structure of the Ph.D. which has historical and philological origins. Also, a broader course of study may for some students provide a better scholarly training than the concentration on a research thesis that is the essence of the Ph.D. program. Many are admirable teachers who eagerly keep up with the flow of scholarship and yet who are not temperamentally suited to following the prescribed Ph.D. program. Because of the unique role of the Ph.D. many such persons complete part of the requirements for the degree, but do not complete all of them and decline in effectiveness because of the appearance of failure that such an inconclusive program presents. The Phil.M. recognizes that there is a place in the academic profession for the able and dedicated teacher who is interested in mastering and passing to his students what is already known without necessarily undertaking to add immediately to this knowledge in the training that he undertakes though he may later on engage in sustained research. When the place of such a teacher is recognized and a suitable program for his training is developed, such as the Phil.M. program, this permits an important clarification in the Ph.D. program and an improvement of it since the intake to Ph. D. programs is then restricted to those who want training that is specifically oriented toward research.

The special nature of the Phil.M. degree has meant that it has been established only for those departments that wished to adopt the program and not for all departments in the University of Toronto. So far 16 departments - all of them in the humanities and social sciences - have chosen to offer the Phil.M. degree.

The University of Waterloo, which also offers the Phil.M., does so in mathematics, as well as in three departments in the humanities. In England, at the Universities of Cambridge and of London, the Phil.M. is given in chemistry, electrical engineering, and some other sciences as well as by departments in the humanities and social sciences. The University of Reading also gives a Phil.M. In the United States, Yale University has introduced the Master of Philosophy with requirements similar to those of the Canadian universities, and other universities are considering following this lead.

The course of studies leading to the Master of Philosophy at the University of Toronto requires full-time residence for a period of two years beyond the Honours B.A. degree in the same discipline, and consists chiefly of courses and seminars. In addition, the candidates write a major essay or research paper which reflects independent scholarship though it does not necessarily represent an original contribution to knowledge. The purpose is to avoid the exhaustive research necessary to make the contribution to knowledge required of a Ph.D. thesis that is the cause of the characteristically long delay in completing the Ph.D. degree. The intention is that the candidates for the Master of Philosophy should complete all the work for the degree and receive it within the two year period of required residence. Indeed, a limit of one year beyond the years of residence is placed on the time during which the requirements must be completed. Should a student already have a Master of Arts degree, residence credit of one year may be given him because of the M.A. as is the case when a student enrolls for a Ph.D. program.

The School of Graduate Studies was concerned lest this new degree be suspected of being used to bail out weak Ph.D. candidates or even of being given to candidates who had failed a portion of their Ph.D. program. Such use for the Phil.M. is impossible. The School of Graduate Studies established standards for admission for Phil.M. candidates that exceed those for the Ph.D. degree thus making it impossible to change a registration from a Ph.D. to a Phil.M. program except during a brief period at the very beginning of the Ph.D. program. Whereas admission to both M.A. and Ph.D. candidacy is possible for students who have II class Honours standing, admission to a Phil.M. program is only possible for students who have achieved an average of at least 70 per cent in their earlier work at the University of Toronto or the equivalent of that standing elsewhere. This does not mean that candidates for the Ph.D. are in fact usually weaker than candidates for the Master of Philosophy. The regulations of the School of Graduate Studies only set minimum standards and departments can then guide students on the basis of any higher standards that the departments may judge fit. However, experience so far has shown that Phil.M. candidates are on the average quite as strong in their earlier academic achievement as are Ph.D. candidates.

Though the Phil.M. program is designed to meet needs different from those that are served by the Ph.D. program, following a Phil.M. program nevertheless does not bar a student whose interests change from continuing into a Ph.D. program. Thus a Phil.M. candidate may transfer into a Ph.D. program at virtually any stage of his progress and a holder of a Phil.M. may proceed to the Ph.D. by being in residence for one more year. Thus a person proceeding to the Ph.D., but who takes the Phil.M. on the way, is not subject to additional residence though he satisfies more course or other requirements than a student who has concentrated on obtaining the Ph.D. only.

A danger exists that this attempt to expand the traditional structure of graduate degrees will run into prejudice because of the unfamiliarity with the degree and the possible suspicion that it is a second-class Ph.D. A knowledge of the purposes of the degree and the standards required to obtain it dispel this doubt and it is particularly important for the development of the new degree that no misunderstanding should remain. It is important too for the welfare of Canadian universities that they should not fail to appropriately use persons with a high level of training because of the newness of the degree they hold. It is vital to the careers of those who have courageously enrolled for a new degree that no misunderstanding should exist of its significance.

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REQUIREMENTS FOR THE MASTER OF PHILOSOPHY DEGREE AT THE UNIVERSITY OF WATERLOO

The normal pattern in proceeding to the M.Phil. Degree is B.A. (or B.Math.), M.Phil., whereas to the Ph.D. degree it is Bachelor's Degree, Master's Degree, Ph.D. The candidate must have an adequate knowledge of at least one language other than English as specified by his department. Seven full courses, acceptable for graduate credit, plus an M.Phil. thesis are required for the M.Phil. Degree. Candidates entering after a Master's Degree will have their Master's courses subtracted from this total. Students must obtain an average of at least 66% in the set of courses which they present in fulfillment of course requirements for the degree.

The candidate shall present a thesis embodying the results of study conducted by himself on an approved topic. The candidate shall defend his thesis in an oral examination before a Committee appointed by the Graduate Studies Committee of his Faculty.

The minimum period of registration for the M.Phil. Degree is two academic years from an Honour Bachelor's Degree or its equivalent or one year from a Master's Degree or its equivalent.

A student may transfer from the M.Phil. programme to the Ph.D. programme in the same field, in exceptional circumstances, by petitioning to the Graduate Studies Committee of his Faculty through his department.

Courses leading to an Honours B. Sc. in Mathematics

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Chemistry 101, 102	MATHEMATICS 220	MATHEMATICS 320	English
French	MATHEMATICS 231	MATHEMATICS 321	MATHEMATICS 421
MATHEMATICS 120	MATHEMATICS 201	MATHEMATICS 330	MATHEMATICS 430
MATHEMATICS 121	MATHEMATICS 234	Philosophy	MATHEMATICS 490
MATHEMATICS 131	Philosophy	Physics 311	One or two from:
Physics 101	Physics 205	Theology	MATHEMATICS 401
Theology			MATHEMATICS 440
			MATHEMATICS 460
			MATHEMATICS 470, 471
			MATHEMATICS 480
			Philosophy or Theology

Courses leading to a B.Sc. with a Major in Mathematics

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Chemistry 101, 102	MATHEMATICS 221	MATHEMATICS 234	English
French	MATHEMATICS 232	MATHEMATICS 331	MATHEMATICS 321
MATHEMATICS 120	One from:	MATHEMATICS 320	MATHEMATICS 330
MATHEMATICS 131	MATHEMATICS 201	Philosophy	MATHEMATICS 490
Physics 101	MATHEMATICS 240	Physics 311	One from:
Theology	Philosophy		MATHEMATICS 401
One Elective	Physics 205		MATHEMATICS 440
(in 2nd term) from:	Theology		MATHEMATICS 460
Biology 101			MATHEMATICS 470, 471
Geot.Sc.202			MATHEMATICS 480
MATH 121			Philosophy or Theology

Courses leading to a General B.Sc. in Mathematics

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Chemistry 101, 102	MATHEMATICS 221	English	MATHEMATICS 320
MATHEMATICS 120	MATHEMATICS 232	MATHEMATICS 201	MATHEMATICS 331
MATHEMATICS 131	Philosophy	MATHEMATICS 234	Philosophy or Theology
French	Theology	MATHEMATICS 240	
Physics 101	One Elective	Philosophy	One Elective
Theology			
One Elective (in 2nd term) from:			
Biology 101			
Geot.Sc. 202			
MATH 121			

Courses leading to an Honours B.A. in Mathematics

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Classics	Classics	French	English
English	MATHEMATICS 220	MATHEMATICS 320	MATHEMATICS 421
French	MATHEMATICS 231	MATHEMATICS 321	MATHEMATICS 430
MATHEMATICS 120	MATHEMATICS 201	MATHEMATICS 330	MATHEMATICS 490
MATHEMATICS 121	MATHEMATICS 234	Theology	One or two from:
MATHEMATICS 131	Philosophy		MATHEMATICS 401
Theology			MATHEMATICS 440
			MATHEMATICS 460
			MATHEMATICS 470, 471
			MATHEMATICS 480
			Philosophy

Courses leading to a B.A. with a Major in Mathematics**

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Classics	Classics	English	MATHEMATICS 320
English	French	MATHEMATICS 234	MATHEMATICS 321
French	MATHEMATICS 221	MATHEMATICS 331	MATHEMATICS 330
MATHEMATICS 120	MATHEMATICS 232	One from:	MATHEMATICS 490
MATHEMATICS 121 or	Elective	MATHEMATICS 201	Elective
Biology 101	Philosophy	MATHEMATICS 240	Philosophy
MATHEMATICS 131		Theology	
Theology			

** Those students who wish to major in mathematics at the 2nd year level with a credit in mathematics 101 should consult the chairman of the department.

EDITOR'S ACKNOWLEDGEMENTS

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J.B.S.

JOBS MARKING ASSIGNMENTS

A limited number of jobs of marking mathematics assignments are open to Junior and Senior students only. Any student interested is advised to fill out the slip given below and submit it as soon as possible to the Secretary, Mrs. M. Pecknold (Math. Dept., Room 26).

----------Tear Off ----------Tear Off----------

APPLICATION FOR MARKING

NAME:---------- Phone ---------

LOCAL ADDRESS:----------

FACULTY:---------- Year ----------

Interested in Marking:	Mark Obtained when Taking this Course
1st Choice	
2nd Choice	
3rd Choice	